GeoHealth

COMMENTARY

10.1029/2024GH001022

Health-Damaging Climate Events Highlight the Need for Interdisciplinary, Engaged Research

Jennifer D. Stowell[1], Susan Anenberg[2], Benjamin F. Zaitchik[3], Daniel Q. Tong[4], Claire J. Horwell[5], Dennis P. Stolle[6], Rita R. Colwell[7], and Christine McEntee[8]

[1]Boston University School of Public Health, Boston, MA, USA, [2]Milken Institute School of Public Health, Washington, DC, USA, [3]Johns Hopkins University, Baltimore, MD, USA, [4]George Mason University, Fairfax, VA, USA, [5]Durham University, Durham, UK, [6]American Psychological Association, Washington, DC, USA, [7]University of Maryland, College Park, MD, USA, [8]CWMcEntee LLC, Arlington, VA, USA

Key Points:

- Climate change is increasingly impacting populations across the globe
- Funding for interdisciplinary research in climate and health has lagged behind biomedical research
- We call for a more proactive effort to encourage interdisciplinary research into the negative effects of climate change

Correspondence to:

J. D. Stowell,
stowellj@bu.edu

Citation:

Stowell, J. D., Anenberg, S., Zaitchik, B. F., Tong, D. Q., Horwell, C. J., Stolle, D. P., et al. (2024). Health-damaging climate events highlight the need for interdisciplinary, engaged research. *GeoHealth*, *8*, e2024GH001022. https://doi.org/10.1029/2024GH001022

Received 23 JAN 2024
Accepted 6 FEB 2024

Author Contributions:

Conceptualization: Jennifer D. Stowell, Susan Anenberg, Benjamin F. Zaitchik, Daniel Q. Tong, Claire J. Horwell, Dennis P. Stolle, Rita R. Colwell, Christine McEntee
Writing – original draft: Jennifer D. Stowell
Writing – review & editing: Jennifer D. Stowell, Susan Anenberg, Benjamin F. Zaitchik, Daniel Q. Tong, Claire J. Horwell, Dennis P. Stolle, Rita R. Colwell, Christine McEntee

Abstract In 2023 human populations experienced multiple record-breaking climate events, with widespread impacts on human health and well-being. These events include extreme heat domes, drought, severe storms, flooding, and wildfires. Due to inherent lags in the climate system, we can expect such extremes to continue for multiple decades after reaching net zero carbon emissions. Unfortunately, despite these significant current and future impacts, funding for research in climate and health has lagged behind that for other geoscience and biomedical research. While some initial efforts from funding agencies are evident, there is still a significant need to increase the resources available for multidisciplinary research in the face of this issue. As a group of experts at this important intersection, we call for a more concerted effort to encourage interdisciplinary and policy-relevant investigations into the detrimental health effects of continued climate change.

Plain Language Summary Recent climate events highlight the need for additional funding for interdisciplinary research focused on the impact of climate on human health.

1. Introduction

In 2023, devastating climate-related heat waves, fires and storms have captured and dominated the attention of the global community. These events have obvious environmental, social, and human health impacts. Moreover, as climate change continues, these repercussions will continue to multiply. Often, these impacts are unevenly distributed, cross geographic and demographic boundaries, and impact individuals least responsible for our warming environment, including children and youth (Haines et al., 2019). Unfortunately, due to significant lags inherent in the climate system, the impacts we are experiencing today reflect human activity from as far back as the 1980 and 1990s. The long-term impacts of past anthropogenic activity imply that, even if we achieve carbon neutrality tomorrow, we can expect to experience frequent and/or extreme climate events for another 30–40 years. This delay in consequences, coupled with the increasing frequency and severity of events, has considerable implications for our ability to plan for future climate extremes and their associated influence on health and infrastructure across the globe. However, our ability to respond to current and future impacts of climate extremes is dampened by the availability of funding mechanisms to bolster research in these areas.

One example of climate extremes of concern is the increased wildfire activity seen in many parts of the globe. In many areas, local wildfire seasons now start earlier and last longer due to the warming of the atmosphere (Liu et al., 2010). This increase in fire activity can threaten human health in multiple ways. First, there are injuries and deaths among local residents caused by the fires themselves—either through direct contact with the fire and smoke, or complications arising from evacuation. This threat was recently illustrated by the tragic Maui wildfire event in August 2023 that claimed many lives and is now ranked as one of the worst fires in modern US history. Second, wildfires are also associated with less immediate health threats posed by the high concentration of pollutants in wildfire smoke. Wildfire smoke contains many toxic substances from burning biomass and materials in our built environment. The resulting mixture of pollutants has been associated with increases in risk of respiratory disease, cardiovascular disease, and mortality and may be more toxic than pollution from other sources (Reid et al., 2016). Further, the pollution resulting from wildfires affects mental health, in addition to physical health. For example, new and ongoing research suggests wildfire smoke can adversely affect cognitive performance and processing and a recent study found that 67% of people directly exposed to California's 2018 Camp Fire experienced trauma and displayed cognitive deficits (Grennan et al., 2023).

In the US, the western states often experience significant wildfire smoke exposure. With continued warming, population centers in other parts of the country could be increasingly at risk as well. In the summer of 2023, the Northeastern US was exposed to higher concentrations of wildfire smoke than at any time in recent recorded history. This unprecedented event was due to the combination of significant wildfire activity in Canada and a low-pressure weather system that settled over Nova Scotia and Maine, causing smoke to be directed toward the eastern coast of the US. Incidents like this Northeastern US smoke event (and many others) points to the potential growth in numbers of individuals exposed to wildfire smoke with continued climate change.

The world has also seen other climate-driven environmental hazards increase in recent years, and continued warming is expected to spur more frequent and intense climate-related hazards, including heat waves, droughts, dust storms, and intense flooding (McBean et al., 2009). Exposure to extreme temperatures is on the rise in many parts of the globe, bringing more frequent heat waves, or consecutive days of extreme heat (Luber et al., 2008). Heat waves pose a significant threat to human health and have been associated with multiple adverse health outcomes, including heat-related illnesses (stroke, exhaustion), cardiovascular disease, respiratory disease, kidney disorders, and excess mortality (Rossati, 2017). The mental health impacts of heat waves can also be significant. Increased heat has, for example, been linked to mood and anxiety disorders, schizophrenia, higher use of emergency mental health services, and higher rates of suicide and interpersonal aggression (Kim et al., 2019).

July 2023 broke earlier records for the hottest month ever recorded globally and included dramatic regional heat extremes such as the prolonged heat in the Southwestern US, where temperatures up to 119°F/48.3°C persisted for almost 3 weeks (WMO, 2023). Across the Atlantic, parts of Europe also experienced extreme temperatures in July 2023. Southern Europe was highly impacted by extreme heat which contributed to a serious outbreak of wildfire in Greece, forcing evacuations of residents and tourists alike and resulting in multiple fatalities.

In addition to fire and heat, dust storms also have many societal effects, including health and agricultural impacts, transmission of infectious diseases, transportation safety and disruption, and impacts on renewable energy production. As a recent developing example, Valley Fever infections have been rising as a result of increased exposures to soil-dwelling fungi called Coccidioides. Recent reports from the Centers for Disease Control and Prevention (CDC) suggest that previous estimates of Valley Fever may significantly underestimate the actual toll from the disease (CDC, https://www.cdc.gov/fungal/diseases/coccidioidomycosis/statistics.html#two). Historically, this disease has been concentrated in the Southwestern US, but increasing dry summer conditions, higher winds, and wet winters may present an opportunity for increased dust storms to allow the fungus to reach areas yet to be impacted (Pearson et al., 2019). Furthermore, with as many as 156 large hard rock mining sites and over 80,000 smaller, abandoned sites in Arizona alone these increasing dust storms have the potential to substantially increase exposures to metals and other contaminants in mine waste (Lovingood et al., 2004).

Flooding, another climate-related hazard, can be confusing as we tend to think that increased heat leads to increased drought. While this is certainly true, increased heat can also intensify extreme rainstorms and increase the amount of precipitation from single storm events (Yin et al., 2018). Flooding poses multiple threats to human health, including drowning, injuries, infectious water-borne diseases, post-traumatic stress disorder, and depression (Ebi et al., 2021; Woodland et al., 2023). Mid-2023 has, yet again, provided examples of climate-related disasters in the form of flooding. In the US, Vermont was affected by a significant weather system that deluged the area with up to 9 inches of rain in approximately 48 hr. Internationally, several flooding events have occurred in parts of India, Japan, China, and Libya. Libya's catastrophic flooding in September 2023 (a combination of heavy rains and poor infrastructure) and subsequent loss of life is a solemn reminder of the devastating compound impacts of our climate on human well-being, especially in less developed parts of the globe.

The confluence of multiple health-damaging climate events experienced in mid-2023 clearly illustrates the widespread and compounding effects of climate change. As Earth's climate system continues heating up in response to past and current greenhouse gas emissions, aggressive adaptation and mitigation efforts at multiple administrative scales—from local to national and international—are necessary to protect public health. Since our planetary, infrastructure, and health systems are interconnected and interdependent, developing the evidence to support adaptation and mitigation decision-making requires cooperation across multiple disciplines to address this global challenge.

Thus, research at the intersection of climate, environmental science, earth science, ecology, public health, medical anthropology, risk communication, psychology, behavioral science, exposure science, engineering and social

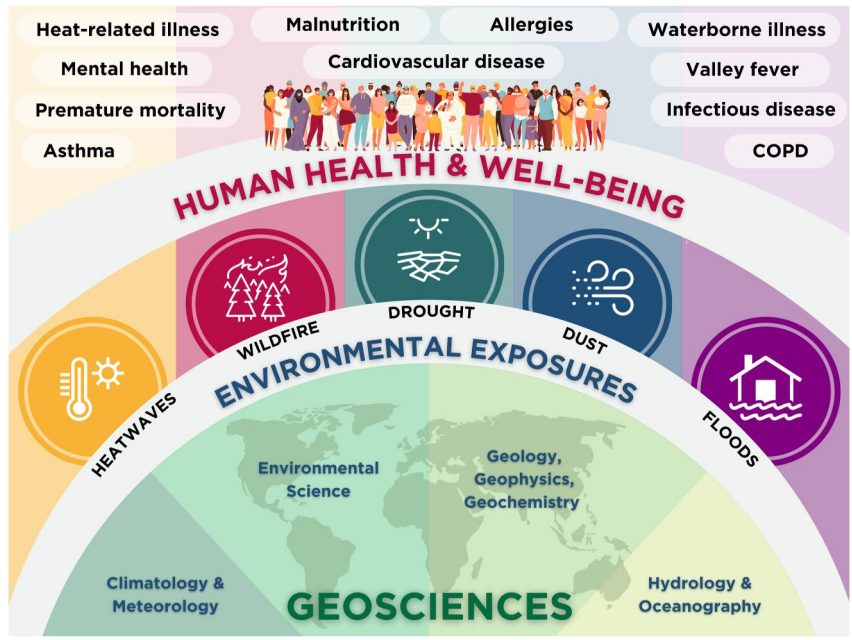

Figure 1. Linking climate-related exposures to geoscience and human health. The geosciences and public health are key links in understanding the impact of the climate change crisis on human populations. It is imperative to increase resources and funding to encourage interdisciplinary research at this important intersection. Greater understanding in these areas can bolster our ability to both respond to and develop resiliency in the face of continued climate change. COPD, chronic obstructive pulmonary disease.

systems is critically needed to address the complex challenges we will continue to face in the coming years (see Figure 1). Some researchers have recognized the magnitude of this effort and have coalesced around the study of geoscience in conjunction with public health. These efforts have been given multiple names, including Geo-Health, Planetary Health, One Health, Medical Geology, or just generally Environmental Health. Regardless of the name, the goal of these efforts is to bring understanding, expertise, tools, and data from multiple disciplines together. Just as the real world is not siloed into individual components, humans and Earth systems are inextricably intertwined.

Similar to the need to deconstruct barriers between these scientific disciplines, engaging partners outside of academia can lead to more actionable research outcomes and will help drive innovative solutions that are feasible, realistic, and just. Recent investment from funding agencies in community-driven science is a key step in our efforts to adapt to climate change. Advances in science are also needed to continue to provide evidence that informs the choices available to governments across the globe. Considering the monumental extent of decarbonization needed to slow global warming and limit temperature levels to those agreed upon by the United Nations Framework Convention on Climate Change, large-scale governmental intervention is needed—especially in moving us away from fossil fuel energy (Matthews et al., 2022). Thus, research to inform national, international, and community scale efforts to demonstrate the health risks of climate change and environmental degradation is increasingly paramount.

Considering the significant undertaking required to address these problems, research funding should not be compartmentalized. Current US funding structures need to evolve to reflect the changing nature of what is important in terms of the environment and our health. For too long, major research funders in the US have largely supported research in traditional disciplines. The National Institutes of Health (NIH) funds medical and health research, while the National Science Foundation (NSF) funds geoscientific research and non-medical biosciences. This segmentation has created roadblocks to research in the realm of climate and health. However, a cross-agency effort to support stakeholder-engaged GeoHealth research would not need to break new ground. Examples of successful programs supporting scientists and community partners to work together to solve real-world problems already exist. The NSF and the NIH have funded a program focused on the ecology of infectious diseases (https://new.nsf.gov/funding/opportunities/ecology-evolution-infectious-diseases-eeid) and the NSF has introduced the

new INTERN program with a focus on linking geosciences to human health by encouraging the expansion of current research to include training in the public health field (https://www.nsf.gov/eng/eec/intern.jsp) as well as a recent letter to expand potential funding for health impacts related to climate change (https://www.nsf.gov/pubs/2024/nsf24013/nsf24013.jsp). The National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and NIH have programs bridging research and action, including NOAA's Climate Adaptation Partnerships (CAP) program (https://cpo.noaa.gov/divisions-programs/climate-and-societal-interactions/cap-risa/), NASA's Health and Air Quality Applied Sciences Team (HAQAST, /https://haqast.org/), and NASA's joint venture with the US Agency for International Development (USAID) named SERVIR (https://www.nasa.gov/servir/) and the NIH Research to Action grant program (https://grants.nih.gov/grants/guide/pa-files/PAR-22-210.html) (https://www.nasa.gov/mission_pages/servir/index.html, https://haqast.org/, Climate Program Office, https://cpo.noaa.gov/Divisions-Programs/Climate-and-Societal-Interactions/CAP-RISA).

Similarly, the UK has also developed strategic interdisciplinary funding pathways over the past decade, through the UKRI Global Challenges Research Fund (https://www.ukri.org/what-we-do/browse-our-areas-of-investment-and-support/global-challenges-research-fund/) and similar initiatives, which support transdisciplinary research (across academic disciplines and beyond academia) through specific research funding and doctoral training programs. The provision of sustainable development and humanitarian funding streams without disciplinary structures has enabled environmental health research to flourish.

We will continue to see climate events destroy communities and harm health and livelihoods as the planet warms and these events affect increasingly broad geographic areas and populations. As they become more frequent, the occurrence of compound hazards will also increase, making these problems more complex and more difficult to address. Now is the time to invest in interdisciplinary, engaged research that will help prepare for the future we expect and help governments make evidence-based decisions about the many societal benefits of reducing greenhouse gas emissions and improving air quality. Institutions of higher education can aid in fueling change by removing historical research "silos" and encourage cross-disciplinary approaches to studying these complex issues. As part of the American Geophysical Union (AGU), the GeoHealth section has worked to highlight the intersection of health and geoscience. As a GeoHealth (One Health, Planetary Health, etc.) community, we will continue to seek opportunities to bridge these gaps and invite the broader research and funding communities to join us as we advance our understanding of climate change and find innovative routes to interrupt the current climate trajectory.

Conflict of Interest

The authors declare no conflicts of interest relevant to this study.

Data Availability Statement

Data were not used, nor created for this research.

Acknowledgments
None.

References

Ebi, K. L., Vanos, J., Baldwin, J. W., Bell, J. E., Hondula, D. M., Errett, N. A., et al. (2021). Extreme weather and climate change: Population health and health system implications. *Annual Review of Public Health*, *42*(1), 293–315. https://doi.org/10.1146/annurev-publhealth-012420-105026

Grennan, G. K., Withers, M. C., Ramanathan, D. S., & Mishra, J. (2023). Differences in interference processing and frontal brain function with climate trauma from California's deadliest wildfire. *PLOS Climate*, *2*(1), e0000125. https://doi.org/10.1371/journal.pclm.0000125

Haines, A., & Ebi, K. (2019). The imperative for climate action to protect health. *New England Journal of Medicine*, *380*(3), 263–273. https://doi.org/10.1056/nejmra1807873

Kim, Y., Kim, H., Gasparrini, A., Armstrong, B., Honda, Y., Chung, Y., et al. (2019). Suicide and ambient temperature: A multi-country multi-city study. *Environmental Health Perspectives*, *127*(11), 117007. https://doi.org/10.1289/ehp4898

Liu, Y., Stanturf, J., & Goodrick, S. (2010). Trends in global wildfire potential in a changing climate. *Ecological Management*, *259*(4), 685–697. https://doi.org/10.1016/j.foreco.2009.09.002

Lovingood, T., Parker, B., Smith, T. N., Canes, H., Fennell, F., Cofer, D., & Reilly, T. (2004). Nationwide identification of Hardrock mining sites.

Luber, G., & McGeehin, M. (2008). Climate change and extreme heat events. *American Journal of Preventive Medicine*, *35*(5), 429–435. https://doi.org/10.1016/j.amepre.2008.08.021

Matthews, H. D., & Wynes, S. (2022). Current global efforts are insufficient to limit warming to 1.5°C. *Science*, *376*(6600), 1404–1409. https://doi.org/10.1126/science.abo3378

McBean, G., & Ajibade, I. (2009). Climate change, related hazards and human settlements. *Current Opinion in Environmental Sustainability*, *1*(2), 179–186. https://doi.org/10.1016/j.cosust.2009.10.006

Pearson, D., Ebisu, K., Wu, X. M., & Basu, R. (2019). A review of Coccidioidomycosis in California: Exploring the intersection of land use, population movement, and climate change. *Epidemiologic Reviews*, *41*(1), 145–157. https://doi.org/10.1093/epirev/mxz004

Reid, C. E., Brauer, M., Johnston, F. H., Jerrett, M., Balmes, J. R., & Elliott, C. T. (2016). Critical review of health impacts of wildfire smoke exposure. *Environmental Health Perspectives*, *124*(9), 1334–1343. https://doi.org/10.1289/ehp.1409277

Rossati, A. (2017). Global warming and its health impact. *The International Journal of Occupational and Environmental Medicine*, *8*(1), 7–20. https://doi.org/10.15171/ijoem.2017.963

WMO. (2023). Copernicus climate change service: Copernicus and WMO: July 2023 is on track to be the hottest month on record.

Woodland, L., Ratwatte, P., Phalkey, R., & Gillingham, E. L. (2023). Investigating the health impacts of climate change among people with pre-existing mental health problems: A scoping review. *International Journal of Environmental Research and Public Health*, *20*(8), 5563. https://doi.org/10.3390/ijerph20085563

Yin, J. B., Gentine, P., Zhou, S., Sullivan, S. C., Wang, R., Zhang, Y., & Guo, S. L. (2018). Large increase in global storm runoff extremes driven by climate and anthropogenic changes. *Nature Communications*, *9*(1), 4389. https://doi.org/10.1038/s41467-018-06765-2